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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: Not yet assigned – 371 of PCT/US00/04401

Filing Date: Not yet assigned

Applicant: Barker

Title: LITHIUM-CONTAINING PHOSPHATE ACTIVE MATERIALS

Attorney Docket: 4858-000080/USB

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Box Patent Applications  
Hon. Commissioner of Patents and Trademarks  
Washington, D.C. 20231

FIRST PRELIMINARY AMENDMENT

Sir:

Applicants herewith submit this First Preliminary Amendment to the application filed herewith, for consideration prior to the calculation of the filing fee, as follows:

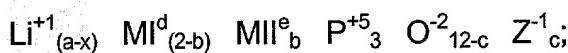
IN THE CLAIMS

Please amend claims 1, 11, 16, 17 and 20 in accordance with the following rewritten claims in clean form. Applicant includes herewith an Attachment for Claim Amendments showing a marked up version of each amended claim.

1. (AMENDED) A lithium ion battery which comprises a positive electrode and a negative electrode; said positive electrode having an active material represented by the formula  $Li_aM'(2-b)M''_bP_3O_{12-c}Z_c$ ,  $0 \leq b \leq 2$ ,  $0 < c < 12$ ,  $a$  is greater than zero and selected to represent the number of Li atoms to balance said formula; where  $M'$  and  $M''$  are the same or different from one another and are each elements selected from

the group consisting of metal and metalloid elements; where Z is a halogen; and where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

11. (AMENDED) An electrochemical cell having an electrode which comprises an active material represented by the following formula:



(A) where each superscript value represents the oxidation states of respective elements in a first condition,  $x = 0$ :

Superscript +1 is the oxidation state of one atom of Li (lithium),

Superscript d is the oxidation state of one atom of MI,

Superscript e is the oxidation state of one atom of MII,

Superscript -1 is the oxidation state of one atom of Z which is a halogen,

Superscript +5 is the oxidation state of one atom of P (phosphorus) and in the case of  $\text{P}_3$  constitutes a total of 15,

Superscript -2 is the oxidation state of one atom of O (oxygen);

(B) MI and MII are the same or different and are each elements independently selected from the group of metal and metalloid elements;

(C) a, c, d and e are each greater than zero; d and e are each at least one;  $0 \leq b \leq 2$ ; c is less than 12; and where a, b, c, d and e fulfill the requirement:  $(a \times 1) + ((2 - b) \times d) + (b \times e) + 15 = (1 \times c) + ((12 - c) \times 2)$ ;

(D) in a second condition represented by said formula with  $0 < x \leq a$ , and in said second condition, said oxidation state of MI is represented by  $d'$  and said oxidation state of MII is represented by  $e'$ , said amount X of Li is removed from said compound, accompanied by a change in oxidation state of at least one of said MI and MII, according to  $((2-b)x(d'-d)) + (b(e'-e)) = X$ ; where  $d' \geq d$  and  $e' \geq e$ ; and where d,  $d'$ , e, and  $e'$  are each less than or equal to 8; and

(E) where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

16. (AMENDED) An electrode having an active material in a first condition represented by the formula  $\text{Li}_{3-x}\text{E}'_{(2-b)}\text{E}''_b\text{P}_3\text{O}_{12-c}\text{F}_c$ ,  $x = 0$ ,  $0 \leq b \leq 2$ ,  $0 < c < 12$ ; where at least one of E' and E'' is an element selected from the group consisting of metals and metalloids; and E' and E'' are the same or different from one another; and in a second condition by said formula where  $0 < x \leq 3$ ; where at least one of E' and E'' has an oxidation state higher than its oxidation state in said first condition; and where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

17. (AMENDED) An electrode which comprises an active material, represented by the nominal general formula  $\text{Li}_a\text{M}'_{(2-b)}\text{M}''_b\text{P}_3\text{O}_{12-c}\text{Z}_c$ ,  $0 \leq b \leq 2$ ,  $0 < c < 12$ , a is greater than zero and selected to represent the number of Li atoms to balance said

formula; where M' and M" are each elements selected from the group consisting of metal and metalloid elements, said M' and M" are the same or different from one another; where Z is a halogen; and where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

20. (AMENDED) An electrode which comprises an active material, represented by the nominal general formula  $\text{Li}_a\text{M}'_{(2-b)}\text{M}''_b\text{Si}_y\text{P}_{3-y}\text{O}_{12-c}\text{Z}_c$ ,  $0 \leq b \leq 2$ ,  $0 \leq c \leq 12$ ,  $0 \leq y \leq 3$ , a is greater than zero and selected to represent the number of Li atoms to balance said formula; where M' and M" are each elements selected from the group consisting of metal and metalloid elements, and said M' and M" are the same or different from one another; and where Z is a halogen.

**REMARKS**

Claims 1, 11, 16, 17 and 20 have been amended. Claims 1 through 22 remain pending in the application. Support for the claim amendments can be found at least at pages 6, 11, 29 and 30 of the Specification and in the claims as filed. Consideration of the application as amended is requested.

If for some reason Applicant has not paid a sufficient amount with the filing of this application, the Commissioner is hereby authorized to charge any fee due or credit any overpayment to deposit account no. 22-0100. A duplicate copy of this document is enclosed for this purpose.

Respectfully submitted,

Dated: 11 Sept 01

By: Linda M. Deschere  
Linda M. Deschere  
Attorney for Applicants  
Registration No. 34,811  
(248) 641-1600

Harness, Dickey & Pierce  
P. O. Box 828  
Bloomfield Hills, MI 48303

**ATTACHMENT FOR SPECIFICATION AMENDMENTS**

The following is a marked up version of each replacement paragraph and/or section of the specification in which underlines indicates insertions and brackets indicate deletions.

1. (AMENDED) A lithium ion battery which comprises a positive electrode and a negative electrode; said positive electrode having an active material represented by the formula  $\text{Li}_a\text{M}'_{(2-b)}\text{M}''_b\text{P}_3\text{O}_{12-c}\text{Z}_c$ ,  $0 \leq b \leq 2$ ,  $0 < c < 12$ ,  $a$  is greater than zero and selected to represent the number of Li atoms to balance said formula; where  $\text{M}'$  and  $\text{M}''$  are the same or different from one another and are each elements selected from the group consisting of metal and metalloid elements; [and] where  $Z$  is a halogen[.]; and where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

11. (AMENDED) An electrochemical cell having an electrode which comprises an active material represented by the following formula:



(A) where each superscript value represents the oxidation states of respective elements in a first condition,  $x = 0$ :

Superscript +1 is the oxidation state of one atom of Li (lithium),

Superscript d is the oxidation state of one atom of MI,

Superscript e is the oxidation state of one atom of MII,

Superscript -1 is the oxidation state of one atom of Z which is a halogen,

Superscript +5 is the oxidation state of one atom of P (phosphorus) and in the case of  $\text{P}_3$  constitutes a total of 15,

Superscript -2 is the oxidation state of one atom of O (oxygen);

- (B) MI and MII are the same or different and are each elements independently selected from the group of metal and metalloid elements;
- (C) a, c, d and e are each greater than zero; d and e are each at least one;  $0 \leq b \leq 2$ ; c is less than 12; and where a, b, c, d and e fulfill the requirement:  $(a \times 1) + ((2 - b) \times d) + (b \times e) + 15 = (1 \times c) + ((12 - c) \times 2)$ ; [and]
- (D) in a second condition represented by said formula with  $0 < x \leq a$ , and in said second condition, said oxidation state of MI is represented by d' and said oxidation state of MII is represented by e', said amount X of Li is removed from said compound, accompanied by a change in oxidation state of at least one of said MI and MII, according to  $((2-b) \times (d'-d)) + (b(e'-e)) = X$ ; where  $d' \geq d$  and  $e' \geq e$ ; and where d, d', e, and e' are each less than or equal to 8[.]; and
- (E) where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

16. (AMENDED) An electrode having an active material in a first condition represented by the formula  $\text{Li}_{3-x}\text{E}'_{(2-b)}\text{E}''_b\text{P}_3\text{O}_{12-c}\text{F}_c$ ,  $x = 0$ ,  $0 \leq b \leq 2$ ,  $0 < c < 12$ ; where at least one of E' and E'' is an element selected from the group consisting of metals and metalloids; and E' and E'' are the same or different from one another; and in a second condition by said formula where  $0 < x \leq 3$ ; [and] where at least one of E' and E'' has an oxidation state higher than its oxidation state in said first condition[.]; and where a portion

of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

17. (AMENDED) An electrode which comprises an active material, represented by the nominal general formula  $\text{Li}_a\text{M}'_{(2-b)}\text{M}''_b\text{P}_3\text{O}_{12-c}\text{Z}_c$ ,  $0 \leq b \leq 2$ ,  $0 < c < 12$ ,  $a$  is greater than zero and selected to represent the number of Li atoms to balance said formula; where  $\text{M}'$  and  $\text{M}''$  are each elements selected from the group consisting of metal and metalloid elements, and said  $\text{M}'$  and  $\text{M}''$  are the same or different from one another; [and] where  $Z$  is a halogen[.]; and where a portion of the phosphorous (P) is substituted by one or more ions having a +4 or +5 valence state selected from the silicon or phosphorous family of the Periodic Table.

20. (AMENDED) An electrode which comprises an active material, represented by the nominal general formula  $\text{Li}_a\text{M}'_{(2-b)}\text{M}''_b\text{Si}_y\text{P}_{3-y}\text{O}_{12-c}\text{Z}_c$ ,  $0 \leq b \leq 2$ ,  $[0 < c < 12]$   $0 \leq c \leq 12$ ,  $[0 \leq y < 3]$   $0 \leq y \leq 3$ ,  $a$  is greater than zero and selected to represent the number of Li atoms to balance said formula; where  $\text{M}'$  and  $\text{M}''$  are each elements selected from the group consisting of metal and metalloid elements, and said  $\text{M}'$  and  $\text{M}''$  are the same or different from one another; and where  $Z$  is a halogen.